Los Alamos National Laboratory
Radiological Protection Program

Second Quarter Report CY 1996

Performance Indicators for Radiation Protection

August 1996

Los Alamos National Laboratory
Environment, Safety and Health Division (ESH-12)
Dose Optimization Team
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MANAGEMENT SUMMARY

INTRODUCTION

This report covers all operations conducted at Los Alamos National Lab (LANL). It includes University of California (UC) operations as well as contractors and subcontractors. The majority of the information (data) in this report comes from three sources. The first source, dosimetry information, is obtained from the Radiation Information Management Team of ESH-12. The remainder of the information is obtained from two sources; from the individual radiological incident reports (RIR's) [LP107-01.1], that are completed by the ESH-1 radiological control technicians (RCT's), and the DOE Occurrence Reporting and Processing System (ORPS) [DOE Order 232.1]. The ESH-12 Dose Optimization Team maintains the RIR and ORPS information in a Microsoft Access database.

The data contained in this report are current as of the date that the report was prepared, and are accurate to the best of the team's knowledge.

1.0 GENERAL SITE INFORMATION

A. Major radionuclides at the site:

Plutonium, Uranium, Tritium and mixed activation products

2.0 EXTERNAL RADIATION EXPOSURE

A. Administrative Control Levels: (Rad Con Manual)

Whole Body DOE ACL .....2.0 rem

Radiation Worker Dose Limits: (10CFR835)

Whole Body..... 5 rem
Skin..... 50 rem
Extremity..... 50 rem

B. Collective Radiation Dose: (person-rem)

	1994	1995	1996 (YTD)
Whole Body Dose (EDE)	178	220	91

C. Individual Data:

(1) Maximum Individual Dose Received: (rem)

	1994	**1995**	**1996**(YTD)
Whole Body Dose (EDE)	1.743	1.949	1.593
Neutron Dose	1.515	1.705	1.257

(2) Average Individual Non-Zero Dose Received (whole body external)**: (rem)**

	1994	**1995**	**1996**(YTD)
Individuals with non-zero dose	0.075	0.088	0.088

D. Number of Personnel in Dose Categories: External (EDE)

Dose Category (rem)	**1994**	**1995**	**1996**(YTD)
Zero	9448	10032	7969
0.001-0.010	843	1028	296
0.011-0.025	752	682	289
0.026-0.050	267	232	118
0.051-0.075	93	98	64
0.076-0.100	57	57	40
0.101-0.250	181	173	134
0.251-0.500	111	124	65
0.501-0.750	46	42	17
0.751-1.000	28	25	10
1.001-2.000	19	46	8
2.001-3.000	0	0	0
3.001-4.000	0	0	0
4.001-5.000	0	0	0
> 5.000	0	0	0
Number Monitored	11845	12539	9010

3.0 PERSONNEL CONTAMINATIONS (DOE Order 232.1 criteria)

A. Number of skin contaminations:

1993 = 32
1994 = 42
1995 = 40
1996 = 26 (YTD)

B. Number of personal clothing contaminations:

1993 = 22
1994 = 28
1995 = 16
1996 = 11 (YTD)

4.0 OCCURRENCES/INCIDENTS

A. Number of DOE Order 232.1 reports filed relating to radiation protection and their classifications:

Year (CY)	Number of Reports (DOE Order 232.1) All	Number of Reports Related to Radiation Protection	Personnel Contamination Reports
1994	265	88	45
1995	253	87	46
1996 (YTD)	129	56	35

B. Number of radiological incidents reported through the RIR system:

Year (CY)	Number of Radiation Incident Reports (RIR)
1993	451
1994	496
1995	549
1996 (YTD)	228

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FIGURES

I. Introduction and Purpose

Part of the process of maintaining radiation exposures as low as reasonably achievable (ALARA) includes monitoring ALARA program objectives. The *LANL Radiological Control Manual* (RadCon Manual) requires the Laboratory Director "to establish, approve, and maintain a radiological performance goals program." And it also specifies that the status of the goals be formally reported. The RadCon Manual also requires quarterly and yearly review of the program (also stipulated in the 10CFR835 Implementation Guide), and it is for that purpose this report is generated. In addition, the University of California (UC) contract, under which the UC operates LANL, requires that "Occupational external and tritium radiation exposures are managed to assure that individual doses do not exceed specified limits. An effective ALARA program is in place to manage dose." This report is a tool used in the tracking and review stages of the performance measure.

II. Scope

This report includes information from all radiological operations at the Laboratory involving radioactive sources, radioactive materials and machine-generated *ionizing* radiation. This report does not consider nonionizing radiation, environmental radiation, or consumer product radiation. It also does not apply to Laboratory radiological operations at the Nevada Test Site or to other Laboratory radiological operations remote to the Los Alamos area.

III. Definitions

Terms used in this report that are defined in the RadCon Manual are not restated here. The following terms have special meaning for this report.

Facility—a building, an area within a building, or a group of buildings that constitutes a logical unit for performance goal determination.

Facility manager—in the context of this report, a person assigned the responsibility for determining, monitoring, and achieving facility performance goals.

Organization—the entire Los Alamos National Laboratory or any management subunit (team/section, group, division).

Performance goal—a value chosen for a performance indicator (see definition below) to provide a target for improving the radiation protection program. The value, challenging but achievable, is based on historical experience, activities expected to be performed during the goal period, and professional judgment.

Performance indicator—a measurable parameter that may be used to suggest the condition of or trend in the radiation protection program. Performance indicators are divided into two groups: organizational and facility indicators. *Organizational* indicators are concerned with personnel exposures, while *facility* indicators are concerned with radiological conditions within buildings.

Radiation worker - an individual receiving an external effective dose equivalent of greater than 100 mrem during the calendar year.

IV. Performance Indicators

The ALARA goals and performance indicators shown below are taken from the *Radiological Performance Goals Program*, Laboratory Standard LS107-05.0. These indicators were selected because they were in keeping with using the fewest number of indicators to provide useful information to management and to trigger improvement. The *10CFR835* Implementation Guide cautions facilities to "select meaningful and measurable performance indicators."

ALARA Goals (Exposure Control)

1. external effective dose equivalent (whole-body dose)
2. average worker external effective dose equivalent (whole body)
3. maximum worker external effective dose equivalent
4. maximum neutron dose to a worker

Radiological Performance Indicators

1. number of DOE order 232.1, radiological occurrences
2. number of skin contaminations
3. number of personal clothing contaminations
4. number of nasal contaminations
5. number of airborne monitor alarms (CAM)
6. number of area contaminations

V. Radiological Control Performance Indicators Presentations

EXPOSURE CONTROL

1.1 External Effective Dose Equivalent - Whole Body

1.2 Average Worker Non-Zero Dose - Whole Body

1.3 Maximum Dose to a Worker - Whole Body

1.4 Maximum Neutron Dose to a Worker

PI Number 1.1 Exposure Control - External Effective Dose Equivalent

PI Definition

The collective external (deep, neutron and tritium) effective dose equivalent (whole body) for monitored individuals in each organization. The deep and neutron dose is measured by the primary dosimeter, i.e., thermoluminescent dosimeter (TLD). The tritium whole body dose is assessed through urinalysis and calculation. The dose equivalent is reported in units of person-rem.

PI Purpose

The purpose of this indicator is to measure the effectiveness of organizational radiological control programs in maintaining collective site personnel external effective dose equivalents below a pre-selected annual goal and as low as reasonably achievable (ALARA).

Comments

The monthly collective external effective dose equivalent will be plotted in order to discern trends. Totals for previous years will be compared to the current year's cumulative dose to evaluate performance. This particular performance goal is in fact a University of California (UC) Performance Measure.

Summary

NMT-9 was the group with the highest dose (YTD) in 1996. This group is located at TA-55, the plutonium processing and handling facility, and is responsible for the production work on the Cassini project.

The current prorated goal for calendar year 1996 set by LANL for this performance indicator is 116 person-rem. The current year-to-date exposure is 91 person-rem, 22% below the goal.

The listing on the following page provides more group details (Table 3), but includes only the top twenty groups that account for 93% of the Laboratory's total.

PI Number 1.1 **Exposure Control - External Effective Dose Equivalent**

TABLE 1
External Effective Dose Equivalent - Yearly
(person-rem)

Year	Cumulative Dose
1989	329
1990	231
1991	163
1992	133
1993	141
1994	178
1995	220
1996(ytd)	91

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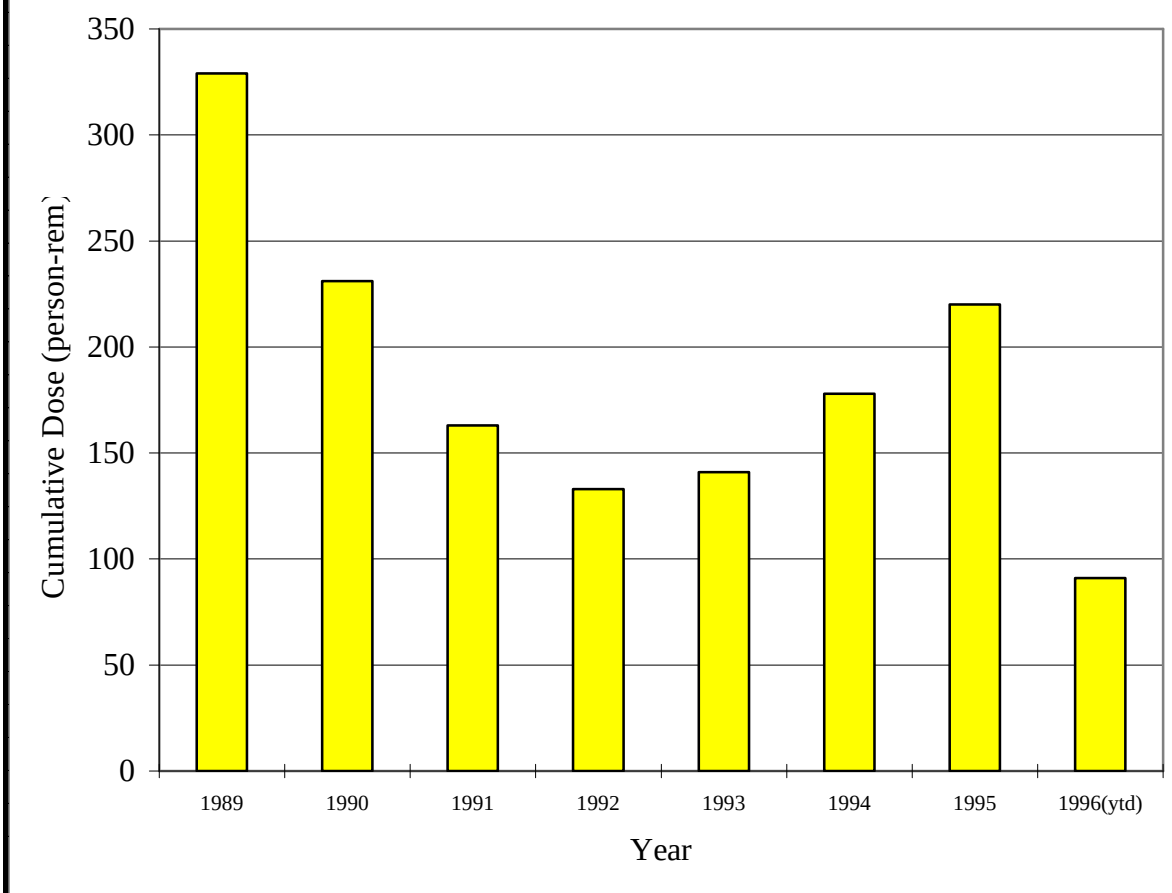

Figure 1

PI Number 1.1 **Exposure Control - External Effective Dose Equivalent**

TABLE 2
External Effective Dose Equivalent
Monthly During 1996
(person-rem)

Month	Monthly Dose
January	14.1
February	15.4
March	16.6
April	12.6
May	17.2
June	15.5
July	
August	
September	
October	
November	
December	

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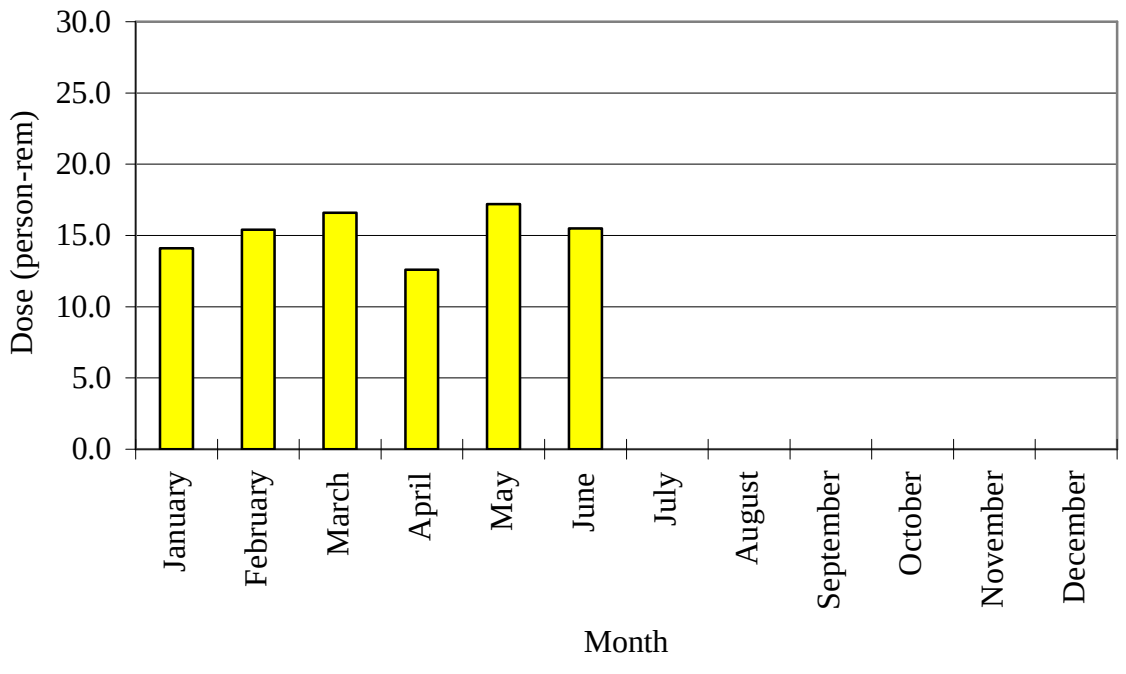

Figure 2

PI Number 1.1 Exposure Control - External Effective Dose Equivalent

TABLE 3
Top Twenty Groups* at
Los Alamos National Laboratory
(person-mrem)

Group Name	Location	Total Dose
NMT-9	TA-55	28091
ESH-1	LANL-WIDE**	11847
JCI	LANL-WIDE**	11465
NMT-2	TA-55	9042
NMT-4	TA-55	5872
NMT-5	TA-55	4211
NMT-7	TA-55	2121
NMT-6	TA-55	1866
NIS-6	TA-18	1520
NMT-8	TA-55	1485
CST-11	TA-48	1341
CST-15	TA-55	1329
AOT-2	TA-53	905
LANSCE	TA-53	851
NIS-5	TA-35	718
ESH-4	TA-3	702
AOT-7	TA-53	547
AOT-6	TA-53	503
ESA-MT	TA-16	489
ESH-14	TA-3	461

*account for 93% of the total LANL dose.

**majority of dose from TA-55.

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PI Number 1.2 Exposure Control - Average Worker Non-Zero Dose

PI Definition

The average worker non-zero external (deep + neutron + tritium) external effective dose equivalent (whole body) for each organization. This dose is measured by the primary dosimeter, i.e. thermoluminescent dosimeter (TLD) for deep and neutron, and by urinalysis and calculation for tritium. This dose equivalent is reported in units of mrem. The average is to be obtained by dividing the total exposure for each evaluation period by the number of individuals at LANL who have non-zero exposures.

PI Purpose

The purpose of this indicator is to measure the effectiveness of organizational radiological control programs in maintaining average worker external effective dose equivalents below a pre-selected annual goal and as low as reasonably achievable (ALARA).

Comments

Each year the average worker non-zero dose - whole body will be plotted. The previous year's dose is also shown in an effort to determine trends.

Summary

This performance indicator can be used as a crudely simplistic method of normalizing dose. Normally an increase in cumulative dose would go hand-in-hand with an increase in the number of workers. As can be seen in figure 3, the overall trend since 1989 has been a decreasing one. Therefore this one performance indicator can be seen as a positive indication of an improved ALARA program.

PI Number 1.2 Exposure Control - Average Worker Non-Zero Dose

TABLE 4
Average Worker Non-Zero Dose
External Effective Dose Equivalent
(mrem)

Year	Average Worker Non-Zero Dose
1989	178
1990	170
1991	124
1992	99
1993	104
1994	75
1995	88
1996	87

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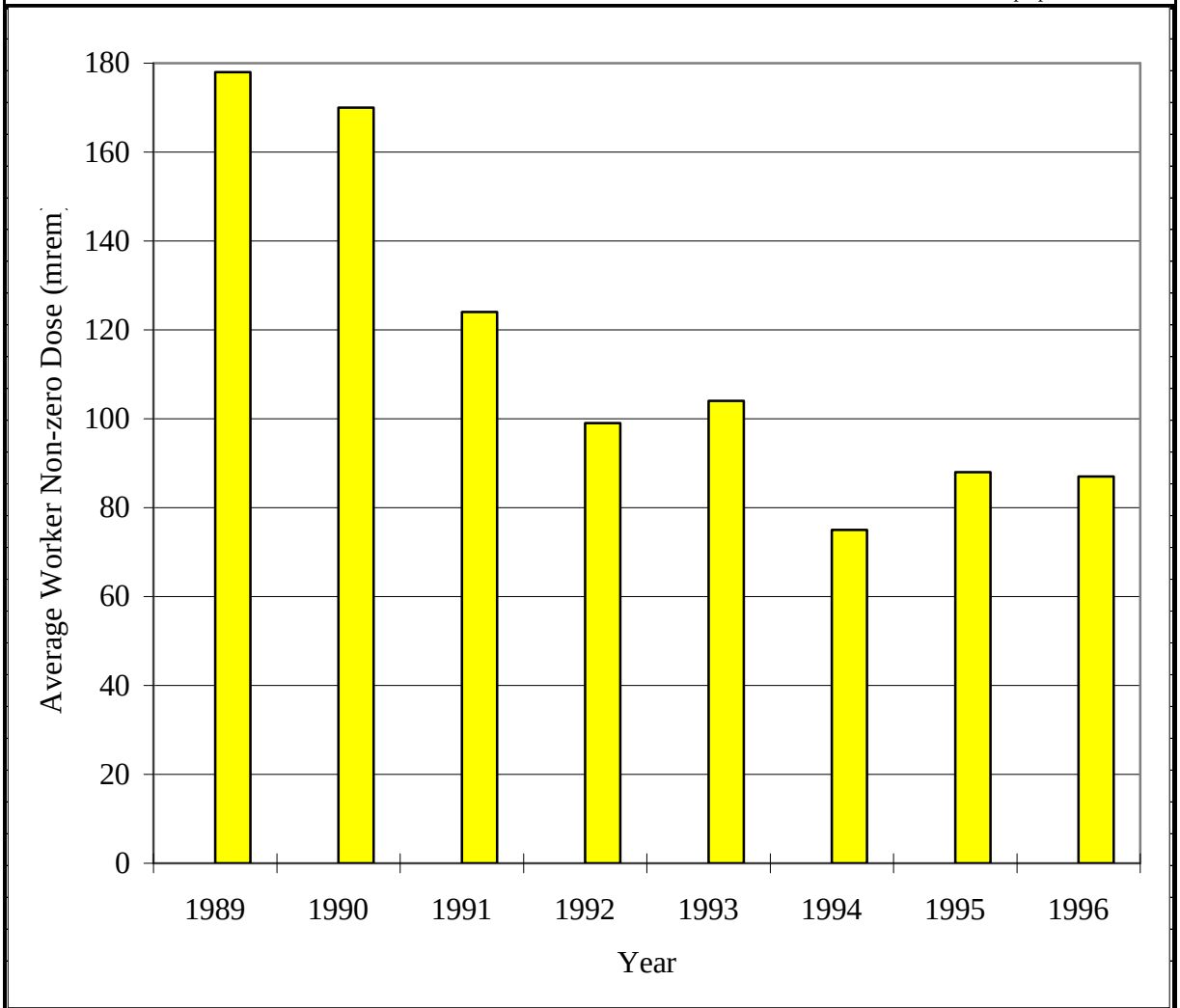

Figure 3

PI Number 1.2 Exposure Control - Average Worker Non-Zero Dose

TABLE 5
Top Twenty Groups at LANL
Average Worker Non-Zero Exposure
(mrem)

Group Name	Location	Average Non-Zero Exposure	Total Group Exposure
NMT-9	TA-55	484	28091
ESH-14	TA-3	230	461
NMT-2	TA-55	184	9042
NMT-4	TA-55	163	5872
NMT-7	TA-55	141	2121
LANSCE	TA-53	141	851
ESH-1	LANL-WIDE*	127	11847
NMT-5	TA-55	120	4211
CST-15	TA-55	102	1329
AOT-7	TA-53	91	547
ESH-4	TA-3	78	702
CST-11	TA-48	74	1341
AOT-6	TA-53	71	503
JCI	LANL-WIDE*	60	11465
NMT-6	TA-55	56	1866
DOE-LAAO	DOE-LAAO	55	279
NIS-18	TA-3	50	101
ESA-MT	TA-16	48	489
NMT-8	TA-55	47	1485
AOT-2	TA-53	45	905

*majority of dose from TA-55 *d:\excel\pirp96\table05.xls*

PI Number 1.3 Exposure Control - Maximum External Effective Dose Equivalent to a Worker

PI Definition

The maximum external (deep + neutron + tritium) effective dose equivalent (whole body) to a worker in each month. This dose is measured by the primary dosimeter, i.e., thermoluminescent dosimeter (TLD) for deep and neutron. The tritium dose is assessed by urinalysis and calculation. This dose equivalent is reported in units of mrem.

PI Purpose

The purpose of this indicator is to measure the effectiveness of organizational radiological control programs in maintaining the maximum external effective dose equivalent (whole body dose) to a worker below a pre-selected annual administrative control level and as low as reasonably achievable (ALARA).

Comments

The maximum whole body dose to a worker (cumulative) will be plotted for the year. Data from previous years will be included for comparison.

Summary

During the past two years no individual has exceeded 2000 mrem. As indicated by this and other performance indicators, the majority of external dose exposure is found at TA-55, the plutonium processing and handling facility.

The legal limit for whole body dose is set at 5000 mrem. The maximum dose received at LANL in 1995 was 1949 mrem, which is sixty one percent below the legal limit. And it is also below the LANL imposed ACL (administrative control limit) of 2000 mrem.

PI Number 1.3 Exposure Control - Maximum Dose to a Worker

TABLE 6
Maximum External Effective Dose Equivalent to a Worker
(mrem)

		Individual's		
	Maxium	Group	Group	Location
Year	Dose	Name	Location	ACL
1994	1743	NMT-4	TA-55	2000
1995	1949	NMT-9	TA-55	1950
1996(ytd)	1593	NMT-9	TA-55	1950

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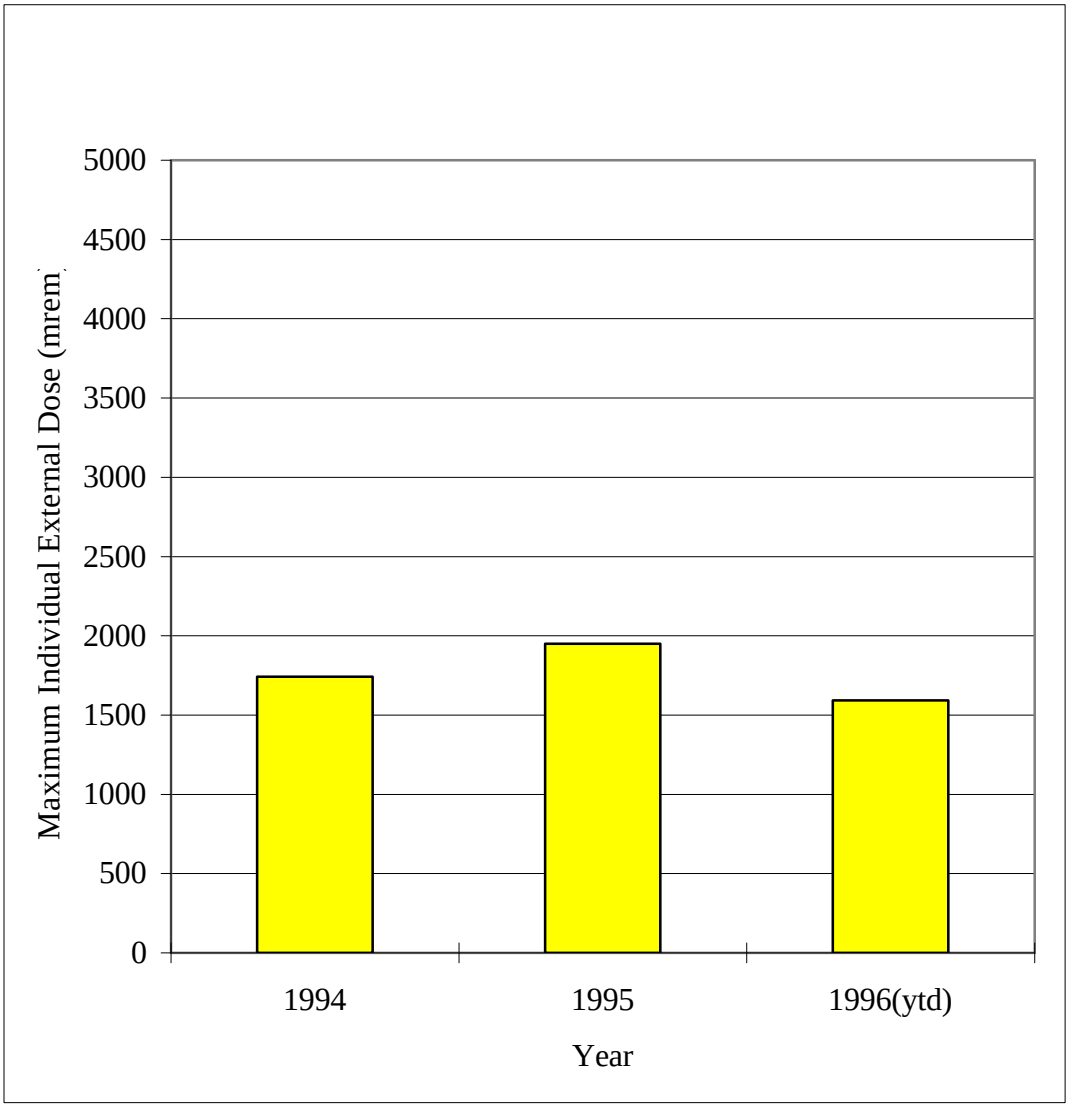

Figure 4

PI Number 1.4 Exposure Control - Maximum Neutron Dose to a Worker

PI Definition

The maximum external effective dose equivalent from neutrons to a worker in each organization as measured by the primary dosimeter, i.e., thermoluminescent dosimeter (TLD). This dose equivalent is reported in units of mrem.

PI Purpose

The purpose of this indicator is to measure the effectiveness of organizational radiological control programs in maintaining the maximum external effective dose equivalent from neutrons to a worker below a pre-selected annual goal and as low as reasonably achievable (ALARA).

Comments

The maximum neutron dose to a worker will be plotted for each month of the year.

Summary

In the second quarter of 1996 the total external exposure was 91 person-rem, while the total neutron exposure was 62 person-rem (sixty eight percent of the total external exposure). The maximum neutron dose to a worker in any one month during 1996 was 441 mrem in January. This value is also the highest one month neutron dose in the past two years. The maximum neutron dose to a worker for all of 1995 was 1705 mrem, as compared to the 1994 value of 1515 mrem.

PI Number 1.4 Exposure Control - Maximum Neutron Dose to a Worker

TABLE 7
Maximum Neutron Dose to a Worker - Monthly
(mrem)

	Exposures		
Month	**1994**	**1995**	**1996**
January	216	252	441
February	194	225	313
March	243	308	317
April	130	316	166
May	156	283	362
June	234	371	345
July	176	216	
August	230	359	
September	198	319	
October	274	219	
November	219	267	
December	168	182	
Max Individual YTD	1515	1705	1257

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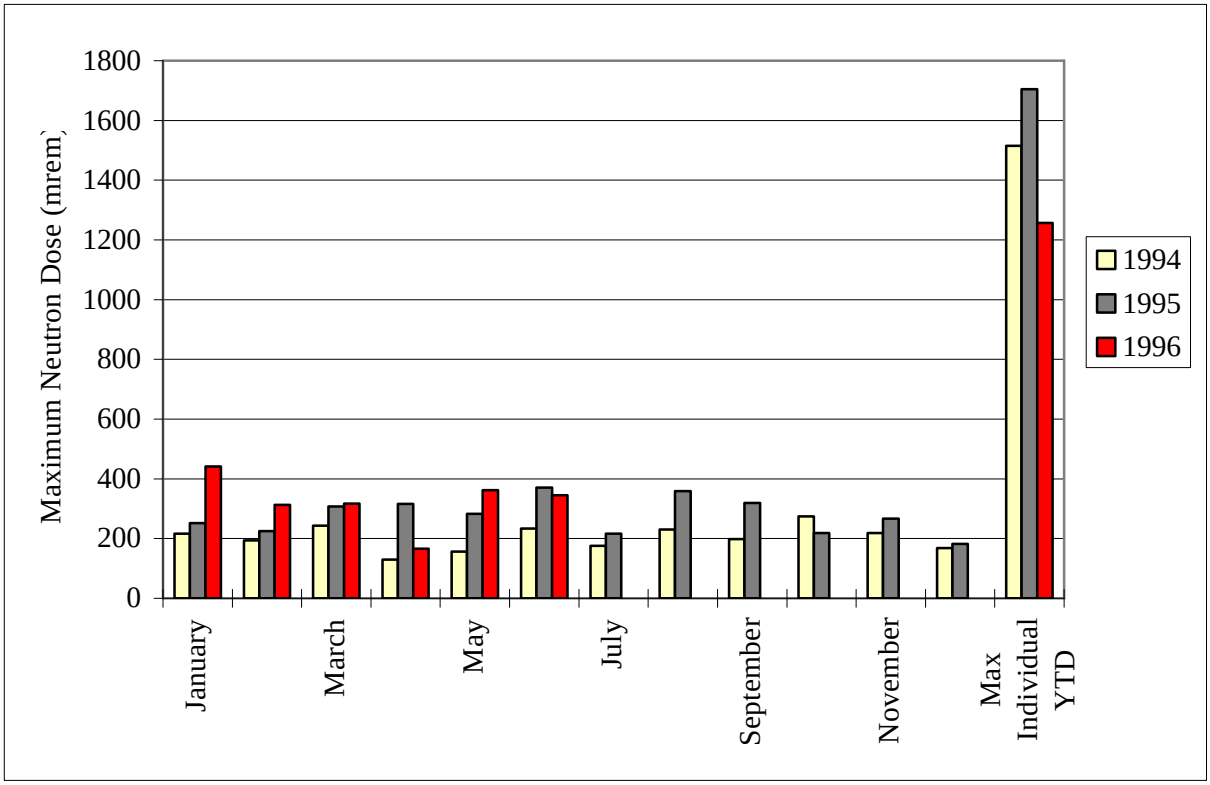

Figure 5

RADIOLOGICAL PERFORMANCE INDICATORS

2.1 Number of DOE Order 232.1, Radiological Occurrences (personnel)

2.2 Number of Skin Contaminations

2.3 Number of Personal Clothing Contaminations

2.4 Number of Nasal Contaminations

2.5 Number of Continuous Airborne Monitor Alarms (CAM)

2.6 Number of Area Contaminations

PI Number 2.1 Radiological Performance Indicators - Number of DOE Order 232.1, Radiological Occurrences (personnel)

PI Definition

The number of DOE Order 232.1 radiological occurrences of a personal contamination nature. These occurrences are skin contaminations, nasal contaminations and personal clothing contaminations.

PI Purpose

The purpose of this indicator is to monitor the performance of the radiological protection program, other than dosimetry.

Comments

To better display the values for this performance indicator (and all remaining performance indicators), the numbers will be divided into four categories. These categories are: total occurrences; then the occurrences at the two main radiological facilities {chemistry and metallurgy research (CMR) and the plutonium processing and handling facility (TA-55)}; and the total remaining occurrences at the other LANL facilities.

The values reported in Table 8 and Figure 6 are the number of occurrence reports, and may not reflect the number of individuals contaminated. Performance Indicators 2.2 - 2.4 will reflect numbers of individuals involved in personnel contaminations.

Summary

The number of radiological occurrences looks to be on an increasing trend for the first half of 1996. During this time period work on the Cassini project was nearing completion. Based upon work estimates, the rate of occurrences should slow during the remainder of 1996.

Normalization

The ratio of radiation workers to occurrences (number of rad workers : number of occurrences) was 8.6 in 1994 (i.e., there was one occurrence for every 8.6 rad workers), 8.9 in 1995 and 6.7 in 1996 (year-to-date).

PI Number 2.1 **Radiological Performance Indicators - Number of DOE Order 232.1, Radiological Occurrences (personnel)**

TABLE 8
Number of DOE Order 232.1
Radiological Occurrences (personnel)

	Number of Occurrences			
Year	**TA-55**	**CMR**	**Others**	**Total**
1993	11	21	6	38
1994	18	13	14	45
1995	25	10	11	46
1996	16	11	8	35

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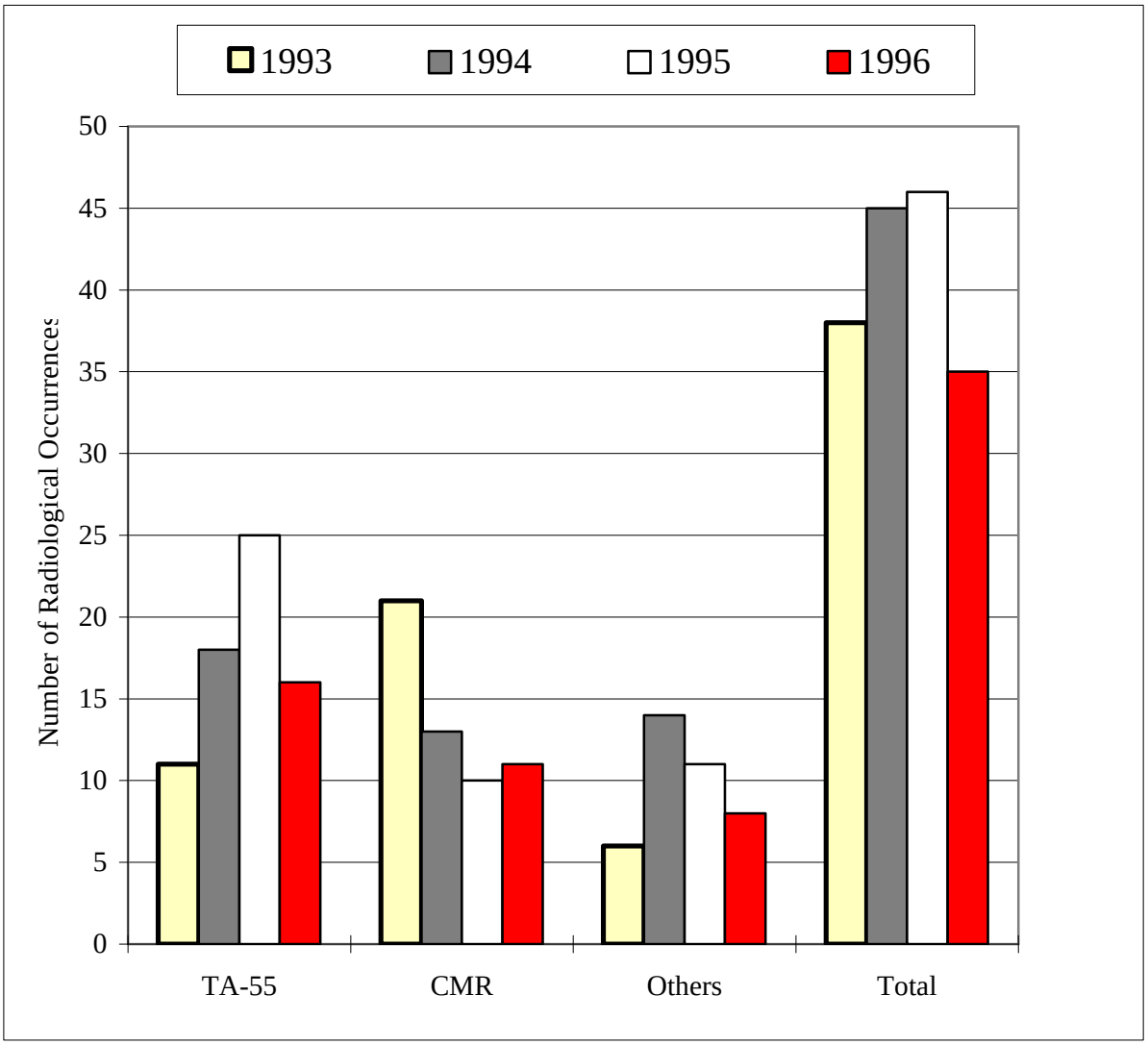

Figure 6

PI Number 2.2 Radiological Performance Indicators - Number of Skin Contaminations

PI Definition

The number of skin contaminations for all personnel (including visitors and contractors) in each organization for which the levels exceeded DOE Order 232.1 reporting levels.

PI Purpose

The purpose of this indicator is to measure the effectiveness of engineered controls and worker performance to contain contamination at the source.

Comments

The number of skin contaminations will be plotted for the year. The totals for previous years will be displayed for trending and comparison.

Summary

The number of skin contaminations has remained steady in all areas at LANL, except at TA-55. The increase in skin contaminations at TA-55 can be attributed to increased production work for the Cassini project.

Normalization

The ratio of radiation workers to skin contaminations (number of rad workers : number of skin contaminations) was 9.2 in 1994 (i.e., there was one skin contamination for every 9.2 rad workers), 10.2 in 1995 and 9.0 in 1996 (year-to-date). This illustrates a steady “normalized” trend for skin contaminations.

PI Number 2.2 Radiological Performance Indicators - Number of Skin Contaminations

TABLE 9
Number of Skin Contaminations

	Number of Occurrences			
Year	**TA-55**	**CMR**	**Others**	**Total**
1993	15	14	3	32
1994	18	8	16	42
1995	27	8	5	40
1996	14	7	5	26

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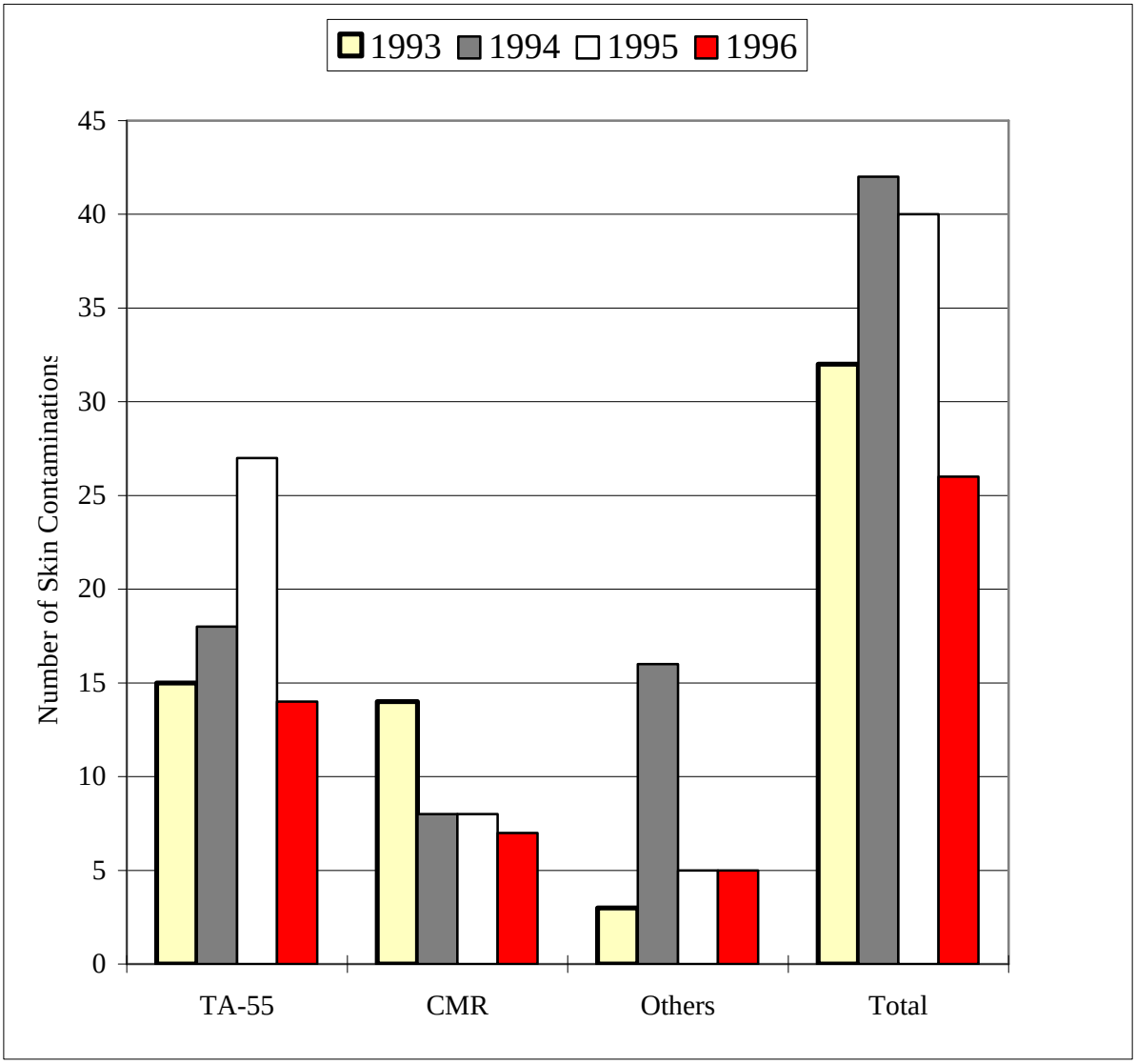

Figure 7

PI Number 2.3 Radiological Performance Indicators - Number of Personal Clothing Contaminations

PI Definition

The number of personal clothing contaminations for all personnel (including visitors and contractors) in each organization for which the levels exceeded DOE Order 232.1 reporting levels.

PI Purpose

The purpose of this indicator is to measure the effectiveness of engineered controls and worker performance to contain contamination at the source.

Comments

The number of personal clothing contaminations will be plotted for the year. The totals for previous years will be displayed for comparison.

Summary

The total number of personal clothing contaminations has remained steady.

Normalization

The ratio of radiation workers to personal clothing contaminations (number of rad workers : number of contaminations) was 13.8 in 1994 (i.e., there was one personal clothing contamination for every 13.8 rad workers), 25.6 in 1995 and 21.3 in 1996 (year-to-date). This illustrates a steady “normalized” trend in personal clothing contaminations.

PI Number 2.3 Radiological Performance Indicator - Number of Personal Clothing Contaminations

TABLE 10
Number of Personal Clothing Contaminations

	Number of Occurrences			
Year	**TA-55**	**CMR**	**Others**	**Total**
1993	0	10	12	22
1994	0	7	21	28
1995	4	3	9	16
1996	0	8	3	11

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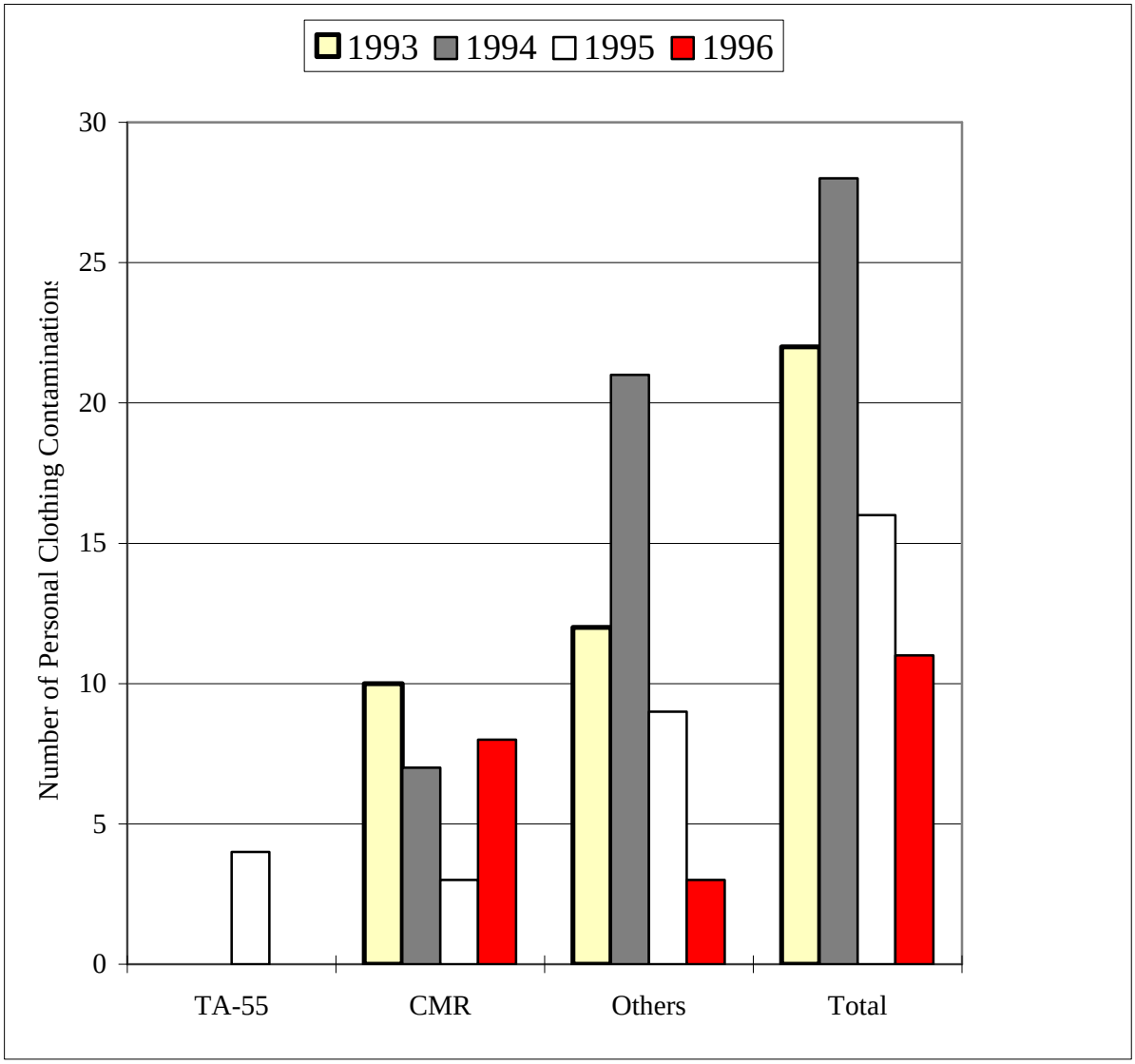

Figure 8

PI Number 2.4 Radiological Performance Indicators - Number of Nasal Contaminations

PI Definition

The number of positive nasal contaminations for all personnel (including visitors and contractors) in each organization for which the contamination exceeded DOE Order 232.1 reporting levels

PI Purpose

The purpose of this indicator is to measure the effectiveness of engineered controls and worker performance to contain contamination at the source.

Comments

The monthly number of nasal contaminations for all personnel will be plotted for the year. Data from previous years (totals) will be included for comparison.

Summary

Any statistical evaluation would be extremely suspect due to the limited number of data points and the purely random nature of the data. Due to the small numbers involved with this performance indicator, no significant trends can be determined.

Normalization

The ratio of radiation workers to nasal contaminations (number of rad workers : number of contaminations) was 128.3 in 1994 (i.e., there was one nasal contamination for every 128.3 rad workers), 205.0 in 1995 and 58.5 in 1996 (year-to-date).

PI Number 2.4 Radiological Performance Indicators - Number of Positive Nasal Contaminations

TABLE 11
Number of Positive Nasal Contaminations

	Number of Occurrences			
Year	**TA-55**	**CMR**	**Others**	**Total**
1993	2	0	0	2
1994	2	0	1	3
1995	2	0	0	2
1996	2	1	1	4

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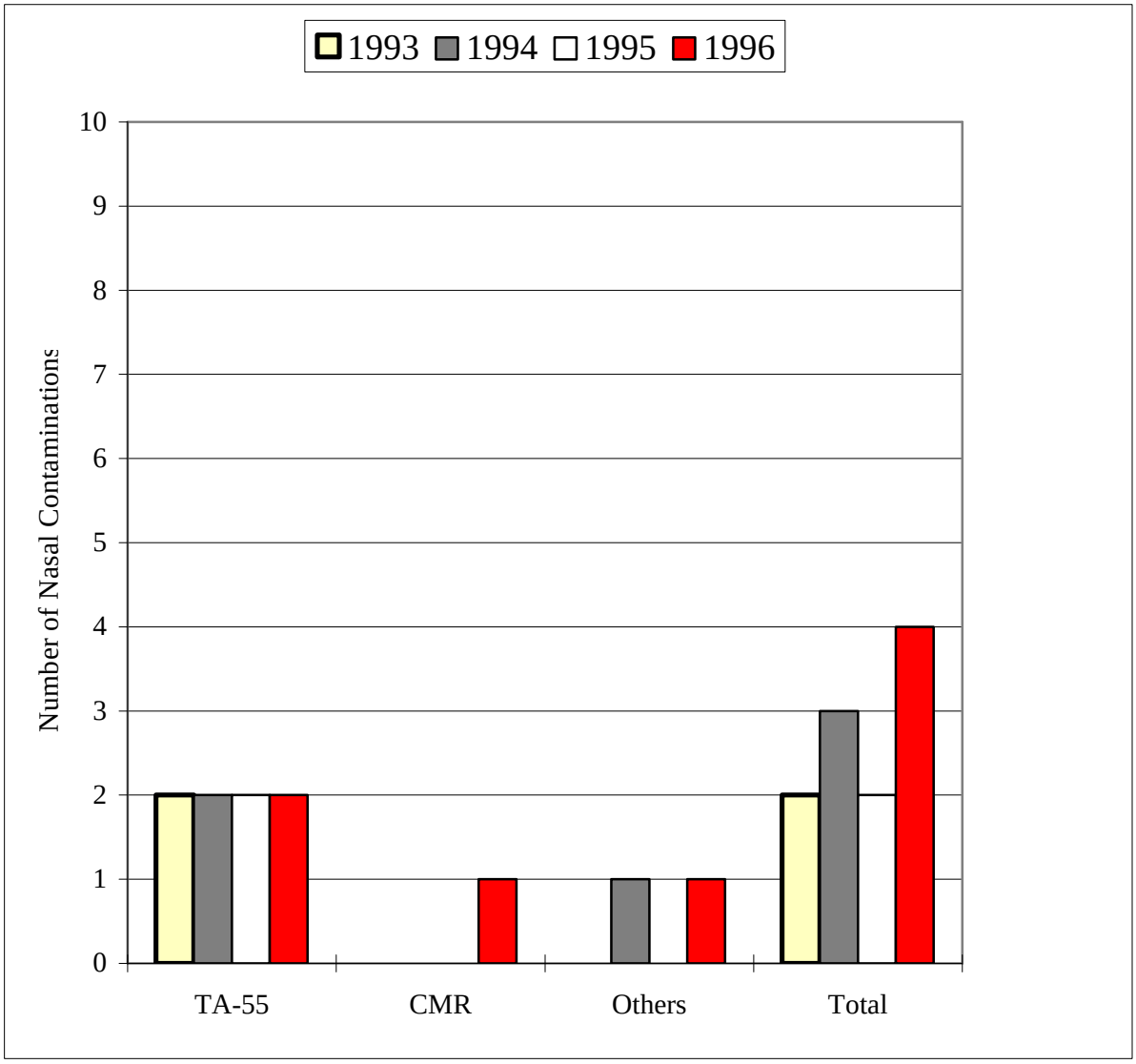

Figure 9

PI Number 2.5 Radiological Performance Indicators - Number of Continuous Airborne Monitor Alarms

PI Definition

The number of true continuous airborne monitor (CAM) alarms for the Laboratory that were reported in accordance with DOE Order 232.1 criteria. True alarms are defined as those alarms that are initiated by the presence of radioactivity on the monitor filter.

PI Purpose

The purpose of this indicator is to measure the effectiveness of facility airborne radioactivity monitoring programs as well as the effectiveness of facility airborne contamination control programs.

Comments

The monthly number of CAM alarms will be plotted for the year. Data from previous years will be included for comparison.

Summary

Due to the small numbers involved with this performance indicator no significant trends can be determined and no normalization will be attempted because of that.

Radiological Performance Indicators -
PI Number 2.5 Number of Positive Continuous Airborne Monitor Alarms

TABLE 12
Number of Continuous Airborne Monitor Alarms (CAM)

Positive CAMs

	Number of Incidents			
Year	**TA-55**	**CMR**	**Others**	**Total**
1993	7	0	0	7
1994	6	1	0	7
1995	1	3	2	6
1996	10	0	2	12

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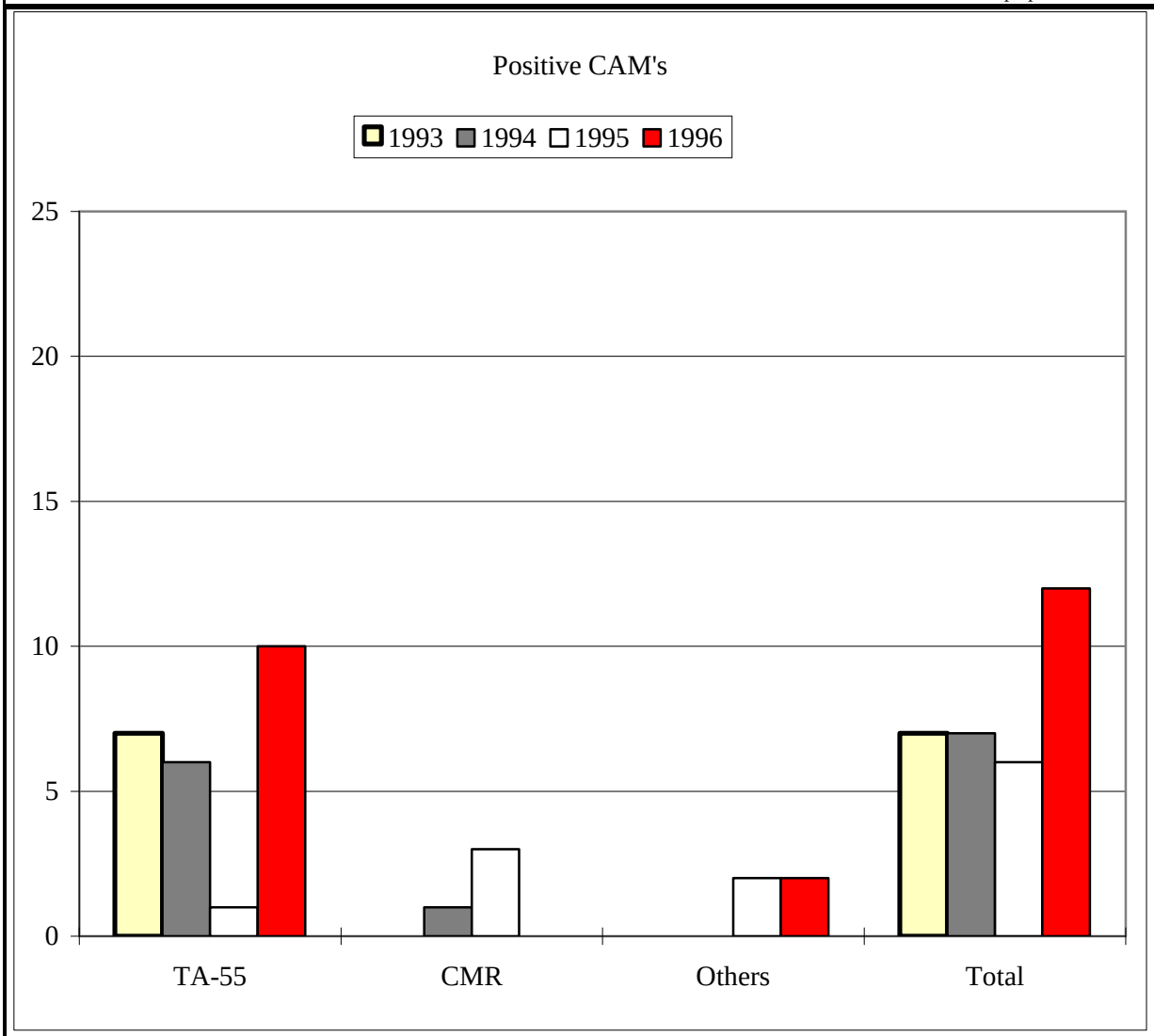

Figure 10

PI Number 2.6 Radiological Performance Indicators - Number of Area Contaminations

PI Definition

The number of area contaminations within the Laboratory boundaries that were reported in accordance with DOE Order 232.1 criteria.

PI Purpose

The purpose of this indicator is to measure the effectiveness of engineered controls and worker performance to contain contamination at the source. The yearly number of area contaminations at the Laboratory will be evaluated against previous years.

Comments

The number of area contaminations will be plotted in comparison to previous years. The specific locations of these contaminations are listed on the reports. The majority of area contaminations are immediately decontaminated and placed back into operation.

Summary

The number of area contaminations has decreased at LANL during the past three years. This trend seems to be continuing for the first half of 1996.

Normalization

The ratio of radiation workers to area contaminations (number of rad workers : number of area contaminations) was 6.5 in 1994 (i.e., there was one area contamination for every 6.5 rad workers), 8.5 in 1995 and 19.5 in 1996 (year-to-date). This illustrates a definite decreasing trend in the rate of area contaminations.

PI Number 2.6 Radiological Performance Indicators - Number of Area Contaminations

TABLE 13
Number of Area Contaminations

	Number of Occurrences			
Year	**TA-55**	**CMR**	**Others**	**Total**
1993	20	23	39	82
1994	10	7	42	59
1995	9	9	30	48
1996	3	4	5	12

d:\excel\pirp96\table13.xls

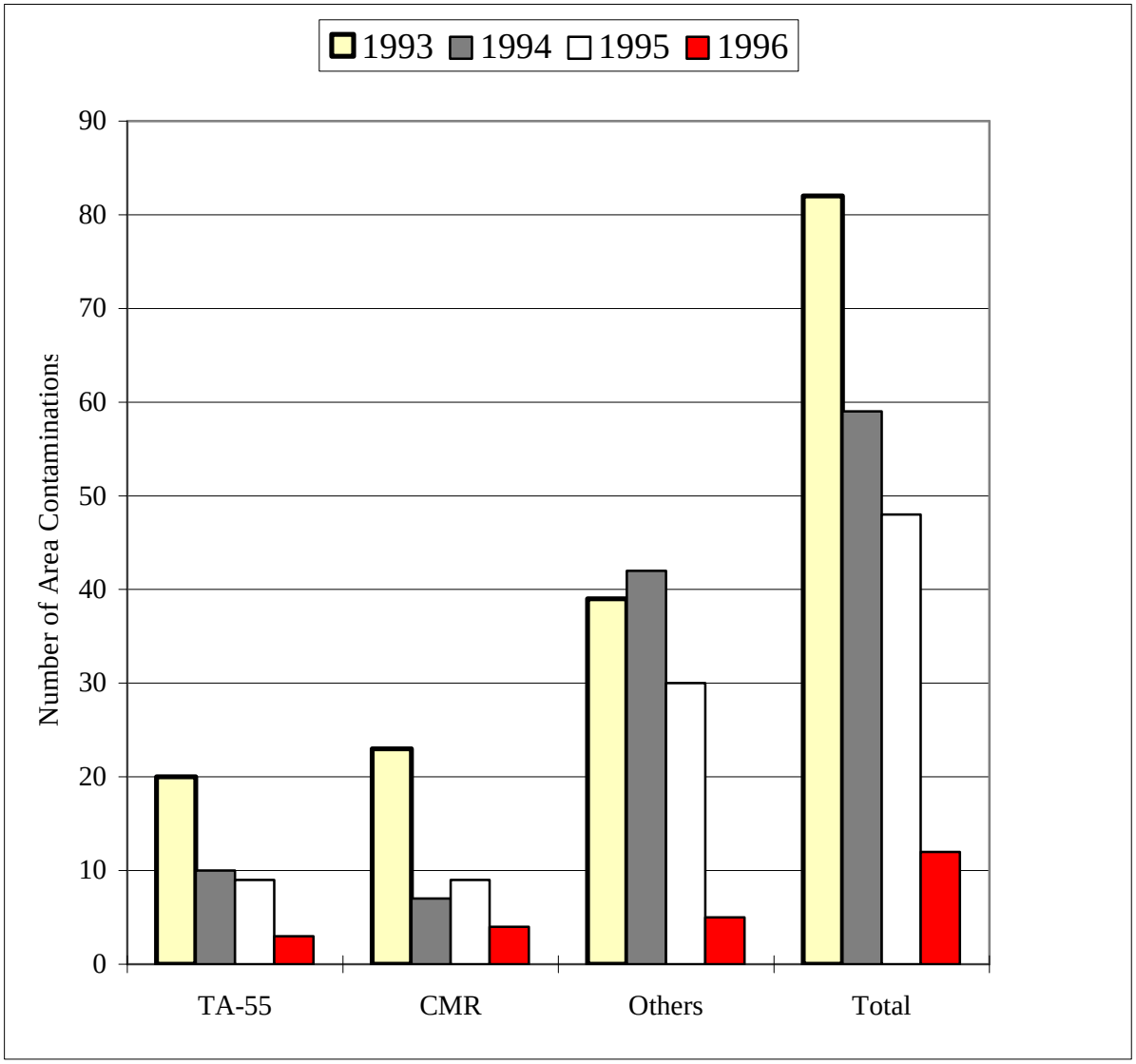

Figure 11